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A COMPARATIVE STUDY OF THE MATHEMATICAL ABILITIES OF BOYS AND GIRLS

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The assertion is frequently made that mathematics is peculiarly adapted to the minds of boys. We are not infrequently asked to believe that the achievements of girls in this subject are decidedly inferior to those of boys. It was with the intention of testing the truth of these assertions that the following investigation was made. The work of 150 boys and 243 girls was investigated. These students entered the Bloomington (Indiana) High School during the four years beginning September, 1906. The investigation included not only a comparison of the mathematical grades but also a comparison of the relative achievements of the boys and girls in mathematics with their relative achievements in English, history, language, and science, which subjects were required of all students completing the high-school course. Science included botany, physical geography, and physics. The history was not required during the first year and therefore many of the eliminated students did not take up this work. Hence conclusions concerning history may not have the same importance as those concerning other subjects.

Table I gives a comparison of the average grades of boys and girls in the several subjects considered. Any differences of averages

in favor of the girls (i.e., showing an advantage in scholarship) are marked positive and those in favor of the boys are marked negative. (This plan is followed in all the tables in which differences are considered.) The differences in mathematics, English, and science are so small as to be negligible; that is, the boys and

TABLE I
A COMPARISON OF AVERAGE GRADES OF BOYS AND GIRLS

	Mathematics	English	Language	History	Science
Boys.....	81.3	83.2	80.4	82.3	80.9
Girls.....	81.0	83.5	82.7	80.3	80.8
Differences.....	-0.3	+0.3	+2.3	-2.0	-0.1

girls have about the same success in these subjects. If we arrange the subjects according to the degree of success with which the girls rival the boys, we have the following order: Language, English, Science, Mathematics, History. This gives mathematics the fourth place, although there is little or no difference in the rank of the last three subjects.

TABLE II
PERCENTAGE OF FAILING GRADES

	Mathematics	English	Language	History	Science
Boys.....	17.8	8.3	13.5	12.5	11.8
Girls.....	16.8	6.6	9.7	10.4	12.5
Differences.....	+1.0	+1.7	+3.8	+2.1	-0.7

Table II shows the percentage of all grades given in each subject which were failures. (The passing grade in the Bloomington High School is 75.) If we arrange the subjects from highest to lowest according to the differences between boys and girls we get the following order: Language, History, English, Mathematics, Science. Thus, although the girls excel with respect to the point under consideration, when compared with the other subjects mathematics occupies the fourth place from the highest.

From the facts considered thus far it seems that, taking into account the entire student body, the girls are the equals of the

boys although they do not excel to the same degree in mathematics as they do in some of the other subjects, especially in language and English.

We shall now give our attention to those students who have been retarded in any high-school subjects.

TABLE III

PERCENTAGE OF STUDENTS TAKING EACH SUBJECT RETARDED BY THAT SUBJECT

	Mathematics	English	Language	History	Science
Boys.....	49.3	25.5	41.1	29.5	27.5
Girls.....	40.5	25.5	29.1	30.5	24.9
Differences.....	+2.8	00.0	+12.0	-1.0	+2.6

Table III shows the percentage of students taking each subject who have been retarded by that subject. Thus, of all the boys who took mathematics 49.3 per cent were retarded by that subject, i.e., they had at some time failed in mathematics. This table shows that a smaller percentage of girls than of boys is retarded by mathematics. Arranging the subjects according to differences we have the following order: Language, Mathematics, Science, English, History.

Table III deals with the retarded students in relation to the entire student body. The next four tables deal with the retarded students as a separate group.

TABLE IV

AVERAGE GRADES OF STUDENTS RETARDED IN ANY SUBJECT

	Mathematics	English	Language	History	Science
Boys.....	77.9	77.4	63.7	79.7	78.4
Girls.....	80.5	80.1	71.1	76.0	77.0
Differences.....	+2.6	+2.7	+7.4	-3.7	-1.4

Table IV shows that the retarded girls, taken as a group, have done better work in mathematics than have the retarded boys. If we arrange the subjects according to differences we get the following order: Language, English, Mathematics, Science, History. Here

mathematics takes the third place, although the difference between mathematics and English is too small to be of any great importance.

TABLE V
PERCENTAGE OF FAILING GRADES AMONG STUDENTS RETARDED IN ANY SUBJECT

	Mathematics	English	Language	History	Science
Boys.....	25.5	12.5	20.6	18.4	22.4
Girls.....	27.3	11.3	16.9	19.0	17.7
Differences.....	-1.8	+1.2	+3.7	- 0.6	+4.7

If we consider the percentage of failing grades among the retarded students we find that it is greater for the girls than for the boys. Table V shows that of all the mathematical grades given to girls retarded in any subject 27.3 per cent were failures while 25.5 per cent were failures in the case of boys. Table III shows that fewer girls than boys are retarded by mathematics, while Table V indicates that among the retarded students mathematics presents more difficulty to the girls than it does to the boys. Arranging the subjects according to differences we have the following order: Science, Language, English, History, Mathematics.

TABLE VI
PERCENTAGE OF RETARDED STUDENTS RETARDED BY ONE SUBJECT ONLY

	Mathematics	English	Language	History	Science
Boys.....	8.0	1.3	5.5	2.9	2.2
Girls.....	9.1	0.4	2.9	2.0	3.1
Differences.....	-1.1	+0.9	+2.6	+0.9	-0.9

Table VI shows that a larger percentage of girls than of boys was retarded by mathematics and at the same time had a clear record in other subjects. Thus 9.1 per cent of all retarded girls were retarded by mathematics but by no other subject, while 8 per cent of the boys were thus retarded. The order of subjects, according to differences, is as follows: Language, History, English, Science, Mathematics.

Table VII gives the percentage of retarded students not retarded by each subject. Thus, of all the boys retarded by any subject

26.7 per cent had a clear record in mathematics. According to this table a larger percentage of retarded boys than of retarded girls was not retarded by mathematics. Arranged according to differences we have: Language, English, Mathematics, History, Science.

TABLE VII
PERCENTAGE OF RETARDED STUDENTS NOT RETARDED BY EACH SUBJECT

	Mathematics	English	Language	History	Science
Boys.....	26.7	62.0	38.7	52.8	58.2
Girls.....	19.5	55.7	50.0	44.9	35.9
Differences.....	-7.2	-6.3	+11.3	-7.9	-22.3

Summing up our data on retarded students we see that, out of the five points considered, the girls excel in two and the boys in three. Thus on the one hand, a smaller percentage of all girls than of all boys in the high school is retarded by mathematics and the retarded girls have a higher average in mathematics than do the retarded boys, while on the other hand, among the group of retarded students mathematics seems to give more difficulty to the girls than it does to the boys. In the comparative study with other subjects mathematics takes a place somewhat lower than English and language.

We shall now consider the grades of students who, for any reason, have been eliminated from school.

TABLE VIII
AVERAGE GRADE OF ELIMINATED STUDENTS

	Mathematics	English	Language	History	Science
Boys.....	79.7	80.2	75.8	77.1	78.4
Girls.....	77.9	81.7	79.0	75.8	76.5
Differences.....	-1.8	+1.5	+3.2	-1.3	-1.9

Table VIII shows that, in mathematics, the average grade of the eliminated girls is smaller than that of the eliminated boys. If we arrange the subjects according to differences we have the following order: Language, English, History, Mathematics,

Science, giving mathematics the fourth place, although the last three are very nearly the same.

TABLE IX
PERCENTAGE OF FAILING GRADES AMONG THE ELIMINATED STUDENTS

	Mathematics	English	Language	History	Science
Boys.....	32.6	19.3	28.4	32.2	24.4
Girls.....	31.9	18.0	21.6	31.2	30.9
Differences.....	+0.7	+1.3	+6.8	+1.0	-6.5

Table IX gives the percentage of eliminated students taking each subject who failed in that subject. Thus, of the eliminated boys taking mathematics, 32.6 per cent failed in that subject. We see that a smaller percentage of eliminated girls than of boys failed in mathematics, although the difference is very slight. Arranging according to differences we have the following order: Language, English, History, Mathematics, Science.

TABLE X
PERCENTAGE OF ELIMINATED STUDENTS FAILING IN ONE SUBJECT ONLY

	Mathematics	English	Language	History	Science
Boys.....	6.0	0.0	6.3	6.3	1.8
Girls.....	7.1	1.0	3.7	1.8	2.4
Differences.....	-1.1	-1.0	+2.6	+4.5	-0.6

As shown in Table X a larger percentage of eliminated girls than of eliminated boys failed in mathematics and at the same time had a clear record in all other subjects. The order of arrangement is as follows: History, Language, Science, English, Mathematics, giving mathematics the fifth place, although the difference between mathematics and English is so small as to be of no importance.

Table XI gives the percentage of eliminated students taking each subject who did not fail in that subject. Thus of all eliminated boys 38.8 per cent did not fail in mathematics. Fewer eliminated girls than boys had a clear record in mathematics. However, this difference is very small. The arrangement of sub-

jects is as follows: English, History, Language, Science, Mathematics.

We have now considered four points in the case of eliminated students and in only one of these have the girls excelled the boys. We should note, however, that in only one case (Table X) is the difference large enough to be of any significance when compared with the numbers of which they are the differences. In other words

TABLE XI
PERCENTAGE OF ELIMINATED STUDENTS NOT FAILING IN EACH SUBJECT

	Mathematics	English	Language	History	Science
Boys.....	38.8	43.8	59.1	40.6	58.9
Girls.....	38.4	57.6	61.7	47.3	59.8
Differences.....	-0.4	+13.8	+2.6	+6.7	+0.9

mathematics does not seem to be a much stronger element in the elimination of girls than it is in the elimination of boys. A study of the relative achievements of boys and girls in the various subjects reveals the fact that the difference of achievements in mathematics is less than in English and in language.

In all, we have considered eleven points and we shall now try to summarize them.

TABLE XII
SUMMATION OF DIFFERENCES

	Mathematics	English	Language	History	Science
Average grades of boys and girls (Table I)	-0.3	+ 0.3	+ 2.3	-2.0	- 0.1
Failing grades (Table II).....	+1.0	+ 1.7	+ 3.8	+2.1	- 0.7
Retardation by subjects (Table III).....	+2.8	0.0	+12.0	-1.0	+ 2.6
Retarded-student grades (Table IV).....	+2.6	+ 2.7	+ 7.4	-3.7	- 1.4
Retarded-student failures (Table V).....	-1.8	+ 1.2	+ 3.7	-0.6	+ 4.7
One-subject retardations (Table VI).....	-1.1	+ 0.9	+ 2.6	+0.9	- 0.9
Non-retardations by subjects (Table VII).....	-7.2	- 6.3	+11.3	-7.9	-22.3
Eliminated-student grades (Table VIII)...	-1.8	+ 1.5	+ 3.2	-1.3	- 1.9
Eliminated-student failures (Table IX)...	+0.7	+ 1.3	+ 6.8	+1.0	- 6.5
One-subject eliminated-student grades (Table X).....	-1.1	- 1.0	+ 2.6	+4.5	- 0.6
Eliminated-student non-failures by subjects (Table XI).....	-0.4	+13.8	+ 2.6	+6.7	+ 0.9
Sums.....	-6.6	16.1	58.3	-1.3	-26.2
Number of positives.....	4	8	11	5	3

Table XII shows that the sum of all the differences in mathematics is slightly in favor of the boys. Of the eleven points only four were in the girls' favor. However, two of the points against the girls are so small as to have but little importance. This gives the boys but very little advantage over the girls.

TABLE XIII
RANKING ACCORDING TO RESULTS OF TABLE XII

	First Place	Second Place	Third Place	Fourth Place	Fifth Place
Ranking according to sums.....	Language	English	History	Mathematics	Science
Ranking according to number of positives	Language	English	History	Mathematics	Science

Table XIII is drawn from Table XII and gives mathematics the fourth place among the subjects with respect to the girls' ability to rival the boys.

As a further check on this conclusion we have weighted the subjects according to their ranking or order in each of the eleven points considered. Thus, in the case of Table I, the order of the subjects was: Language, English, Science, Mathematics, History, and we have therefore assigned to these subjects the numbers 1, 2, 3, 4, 5, respectively. The eleven numbers thus assigned to each subject were then summed. In interpreting these results, which are given in Table XIV, we must remember that the smaller the sum the higher the rank of the corresponding subject. This table gives mathematics the fifth place instead of the fourth as indicated by Table XIII.

In so far as one is justified in drawing any general conclusions from an investigation of the records of pupils of a single high school, we may conclude that, taking the entire student body into consideration, the boys and girls do about the same grade of work in mathematics. Among the retarded students, mathematics has given slightly more trouble to girls than to boys. Mathematics seems, also, to have been a slightly stronger factor in the elimination of girls than in the elimination of boys. When we compare the relative achievements of the girls with those of the boys we find that the girls have done decidedly better in language and English

than they have in mathematics, history, and science. However, if measured by ability to achieve, mathematics is about as well suited to girls as are history and science.

TABLE XIV
EVALUATION OF SUBJECTS BY ASSIGNED WEIGHTS

	Mathematics	English	Language	History	Science
Table I.....	4	2	1	5	3
Table II.....	4	3	1	2	5
Table III.....	2	4	1	5	3
Table IV.....	3	2	1	5	4
Table V.....	5	3	2	4	1
Table VI.....	5	3	1	2	4
Table VII.....	3	2	1	4	5
Table VIII.....	4	2	1	3	5
Table IX.....	4	2	1	3	5
Table X.....	5	4	2	1	3
Table XI.....	5	1	3	2	4
Totals.....	44	28	15	36	42

It will also be of interest to compare the mathematical work of boys and girls in college. For this purpose the records of 191 students who entered the high school during the years 1903-9 and later pursued studies in Indiana University were considered. The investigation of university records was confined to the first-year mathematics, since the number continuing into higher mathematics was too small to permit of reliable conclusions. Of the 191 students entering the university 123 studied mathematics.

TABLE XV
COMPARISON OF RECORDS OF BOYS AND GIRLS IN UNIVERSITY MATHEMATICS

	Number of Group in University	Number Taking Mathematics	Percentage Taking Mathematics	Average Grade	Mean Deviation	Number of Conditions	Percentage of Conditions	Number of Failures	Percentage of Failures
Boys.....	69	48	69.6	83.6	9.7	6	12.5	7	14.6
Girls.....	122	75	61.4	81.9	8.2	2	2.7	5	6.6

Table XV shows that, upon entering the university, 8.2 per cent more boys than girls elect mathematics. The average grade received by the boys is 1.7 per cent greater than that received by the girls. This difference is so small that it has but little significance. Far

more significant is the fact that in the case of the girls the percentages of conditions and failures are decidedly less than in the case of the boys. This with the average grades brings out another important fact. Since the boys' average is somewhat higher than the girls', and since at the same time they have a higher percentage of failures, they must have had some high grades to offset the failures. That is, the boys were not so closely grouped about their average as were the girls. This fact is shown also by the mean deviation.

In order to interpret Table XV more fully we should know from what class of high-school students these boys and girls came. For this purpose all students having completed their high-school mathematics during the given period were divided, according to their high-school grades, into three classes, namely, lowest, middle, highest. Table XVI shows the distribution, among these three classes, of the 123 students who took mathematics in the university.

TABLE XVI

DIVISION OF UNIVERSITY STUDENTS ACCORDING TO HIGH-SCHOOL GRADES IN MATHEMATICS

	LOWEST CLASS		MIDDLE CLASS		HIGHEST CLASS	
	Number	Percentage of All Those Taking Mathematics	Number	Percentage of All Those Taking Mathematics	Number	Percentage of All Those Taking Mathematics
Both boys and girls	22	17.9	40	32.5	61	49.6
Boys.....	9	18.75	16	33.33	23	47.9
Girls.....	13	17.33	24	32.00	38	50.66

Table XVI shows that almost half of the students taking mathematics at the university come from the highest class of high-school students. Also the percentage of girls coming from the highest class is slightly greater than that of the boys, while the percentage of the boys coming from each of the lower classes is slightly larger than that of the girls. This condition tends to increase the importance of the variation of the boys' and girls' university grades as shown in Table XV. However, too much importance must not be attached to this, for the variations of percentages in Table XVI are small.

To determine the movement of the students within the group taking university mathematics, the 123 students were divided into three groups, first according to their high-school grades and second according to their university grades. Tables XVII and XVIII give the results of these divisions. (It is to be noted that Table XVII differs from Table XVI in that the former is a division of the students taking university mathematics on the basis of their high-school grades in mathematics while the latter is based on the division of *all* high-school students who completed their high-school mathematics during the period under consideration.) These two tables

TABLE XVII

DIVISIONS OF THE 123 STUDENTS ACCORDING TO HIGH-SCHOOL GRADES

	LOWEST CLASS		MIDDLE CLASS		HIGHEST CLASS	
	Number	Percentage of All Those Taking Mathematics	Number	Percentage of All Those Taking Mathematics	Number	Percentage of All Those Taking Mathematics
Boys.....	18	37.5	18	37.5	12	25.0
Girls.....	23	30.7	23	30.7	29	38.7

indicate that some of the boys have moved from the lower classes into the highest class, while among the girls there has been a movement from the highest class to the lower classes. This does not mean that the boys have increased their grades over what they were

TABLE XVIII

DIVISION OF THE 123 STUDENTS ACCORDING TO UNIVERSITY GRADES

	LOWEST CLASS		MIDDLE CLASS		HIGHEST CLASS	
	Number	Percentage of All Those Taking Mathematics	Number	Percentage of All Those Taking Mathematics	Number	Percentage of All Those Taking Mathematics
Boys.....	16	33.3	15	31.3	17	35.4
Girls.....	28	37.3	24	32.0	23	30.7

in the high school. The fact is that both boys and girls, upon entering the university, let their grades fall, but the decrease has been slightly greater in the case of the girls. Table XIX brings out this fact. The numbers under the heading "Total Amount of

Increase" were obtained in the following manner: The high-school grades of the students who increased their grades upon entering the university were subtracted from their university grades and the

TABLE XIX
COMPARISON OF HIGH-SCHOOL GRADES WITH UNIVERSITY GRADES

	Number of Students Increasing Grades	Percentage of Students Increasing Grades	Number of Students Decreasing Grades	Percentage of Students Decreasing Grades	Total Amount of Increase	Total Amount of Decrease	Difference between Total In- crease and Total Decrease	Average Decrease
Boys...	16	33 $\frac{1}{3}$	32	66 $\frac{2}{3}$	64	283	219	4.5
Girls...	21	28	54	72	62	480	418	5.6

sum of these differences gave the numbers in question. The numbers under the "Total Amount of Decrease" were found in a similar way. In the case of both boys and girls there was, in general, a decrease in the grades. However, a larger percentage of girls let their grades decrease and their average decrease was slightly larger than that of the boys.

Thus the consideration of the university records of these students indicates that while smaller percentages of girls are conditioned and failed, the girls as a group do not maintain their standing in the university quite as well as do the boys.